

WHAT IS CLAIMED IS:

1. An arbitrarily focused image synthesizing apparatus comprising:

a first filter for converting a first image that is in focus in a first portion based on a given first blur parameter ;

a second filter for converting a second image that is in focus in a second portion based on a given second blur parameter ; and

a synthesizer for synthesizing output of said first filter and output of said second filter and generating an arbitrarily focused image.

2. The arbitrarily focused image synthesizing apparatus according to claim 1, further comprising:

a brightness compensator for performing brightness correction in image block units so that the brightness of said first image and of said second image become about the same, and supplying said images after brightness correction to said first filter and said second filter.

3. The arbitrarily focused image synthesizing apparatus according to claim 2, wherein said brightness compensator uses correction parameters of the block for the center pixel in each block and uses interpolated correction parameters for the other pixels so as to reduce the variation in correction between the blocks.

4. The arbitrarily focused image synthesizing apparatus according to claim 1, further comprising:

a positioning unit that positions said first image and said second image, based on a brightness distribution obtained by projecting image data in horizontal and vertical

directions, and supplying positioned images to said first filter and said second filter.

5. The arbitrarily focused image synthesizing apparatus according to claim 1, further comprising:

a positioning unit that orders each of said first image and said second image hierarchically according to resolution, estimates parameters of differences in the rotation, resizing, and translation in said first image and said second image over a wide search range at a level where the resolution is low, performing matching at each level from upper level to lower level sequentially, while limiting the search range to the margins of the parameters estimated at the upper level, finds the parameters between said first image and said second image so as to position said first image and said second image, and supplying positioned images to said first filter and said second filter.

6. The arbitrarily focused image synthesizing apparatus according to claim 1, further comprising:

a special effects filter for performing prescribed processing on output of said second filter;

wherein said synthesizer synthesizes output of said first filter and output of said special effects filter and generates an arbitrarily focused image.

7. The arbitrarily focused image synthesizing apparatus according to claim 6, wherein said special effects filter adds together pixel data in the lateral direction.

8. The arbitrarily focused image synthesizing apparatus according to claim 6, wherein said special effects filter adds together pixel data in the vertical direction.

9. The arbitrarily focused image synthesizing apparatus according to claim 6, further comprising, on the input side of said special effects filter, a rectangular-to-polar coordinate converter for converting coordinates of respective image data from rectangular coordinates to polar coordinates, and, on the output side of said special effects filter, a polar-to-rectangular coordinate converter for restoring coordinates of image data from polar coordinates back to rectangular coordinates.

10. The arbitrarily focused image synthesizing apparatus according to claim 1, wherein said first image is a near content in-focus image in which near scenic content is focused and said second image is a far content in-focus image in which far scenic content is focused.

11. The arbitrarily focused image synthesizing apparatus according to claim 1, wherein said first filter has characteristic as follows,

$$K_a(\xi, \eta) = \begin{cases} \frac{R_1^2 + R_b^2 - R_a^2}{R_1^2 + R_2^2}, & \xi = \eta = 0 \\ \frac{H_a - H_b H_1}{1 - H_1 H_2}, & \text{otherwise} \end{cases} \quad (23)$$

said second filter has characteristic as follows,

$$K_b(\xi, \eta) = \begin{cases} \frac{R_2^2 + R_a^2 - R_b^2}{R_1^2 + R_2^2}, & \xi = \eta = 0 \\ \frac{H_b - H_a H_2}{1 - H_1 H_2}, & \text{otherwise} \end{cases} \quad (24)$$

wherein R_1 , R_2 , R_a , R_b represent blur radius and H_1 , H_2 , H_a , H_b represent blur function, and

said synthesizer adds output of said first filter to output of said second filter.

12. The arbitrarily focused image synthesizing apparatus according to claim 11, wherein said blur radiuses are selected so that square differential value between an unblurred image and an image subjected to a Gaussian filter is minimized.

13. An arbitrarily focused image synthesizing apparatus comprising:

a determinator for arranging, in focal point order, first to Nth images wherein first to Nth portions, respectively, are in focus based on first to Nth given blur parameters, and determining whether or not one portion in an i'th image that is one of those images is in focus in a plurality of images in front and back thereof taking that i'th image as center;

a comparator for comparing determination patterns of said determinator to determine which images that portion is in focus in; and

a synthesizer for synthesizing said first to Nth images according to comparison results from said comparator and generating a completely focused image.

14. The arbitrarily focused image synthesizing apparatus according to claim 13, wherein said determinator comprises: a Gaussian filter for subjecting said i'th image to filter processing while varying parameters; a differential processor for finding differential values of said plurality of images in front and back with output of said Gaussian filter; and an estimator for estimating said parameters by finding the value at which said differential value is minimized.

15. A plural image simultaneous capturing camera comprising:

a camera element;

18. The plural image simultaneous capturing camera according to claim 15, further comprising an arbitrarily focused image synthesizing apparatus comprising: a first filter for converting a first image that is in focus in a first portion based on a given first blur parameter; a second filter for converting a second image that is in focus in a second portion based on a given second blur parameter; a synthesizer for synthesizing output of said first filter and output of said second filter and generating an arbitrarily focused image; and a positioning unit that positions said first image and said second image, based on a brightness distribution obtained by projecting image data in horizontal and vertical directions, and supplying positioned images to said first filter and said second filter.

19 The plural image simultaneous capturing camera according to claim 15, further comprising an arbitrarily focused image synthesizing apparatus comprising: a first filter for converting a first image that is in focus in a first portion based on a given first blur parameter; a second filter for converting a second image that is in focus in a second portion based on a given second blur parameter; a special effects filter for performing prescribed processing on output of said second filter; and a synthesizer for synthesizing output of said first filter and output of said special effects filter and generating an arbitrarily focused image.

20. The plural image simultaneous capturing camera according to claim 19, wherein, provided on the input side and output side of said special effects filter are a rectangular coordinate to polar coordinate converter for converting coordinates of respective image data from rectangular

coordinates to polar coordinates, and a polar coordinate to rectangular coordinate converter for restoring coordinates of image data from polar coordinates back to rectangular coordinates.